

REMARKS

Applicants previously elected to prosecute Claims 1-10, 25-29, and 31-34, comprising Species I, drawn to a method of controlling copper diffusion using a layer of RuO₂ as a diffusion stuffer having a layer of Ru on the inter-level dielectric substrate.

Specification Objection

The Examiner objected to the Specification for the following reason:

The title of the invention is not descriptive. A new title is required that is clearly indicative of the invention to which the claims are directed (see MPEP § 606.01). Note that, the claims are directed to a method of making a semiconductor device instead of a semiconductor device.

Applicant hereby amends the title of the invention as follows:

**METHOD OF MAKING INTEGRATED CIRCUITS USING RUTHENIUM
AND ITS OXIDES AS A Cu DIFFUSION BARRIER**

Claims Rejections – 35 USC § 103

Examiner rejected Claim 1 under 35 U.S.C. 103(a) as being unpatentable over Omstead et al., U.S. Patent No. 6,713,373 B1 (“Omstead”) in view of the following remark.

Omstead et al. teach a method of controlling and containing copper diffusion during the integration of copper interconnects during the fabrication of integrated circuits, comprising:

- preparing an inter-level dielectric substrate 304;
- depositing a layer of RuO₂ 404 on the inter-level dielectric substrate;
- depositing a layer of Ru as a diffusion stuffer on the RuO₂ layer; and
- depositing copper on the Ru layer.

Omstead et al. does not teach depositing a layer of Ru on the inter-level dielectric substrate;
depositing a layer of RuO₂ as a diffusion stuffer on the Ru layer; and
depositing copper on the RuO₂ layer.

It would have been obvious to a person of ordinary skill in the art at the time the invention was made for depositing a layer of Ru on the inter-level dielectric substrate; depositing a layer of RuO₂ as a diffusion stuffer on the Ru layer; and depositing copper on the RuO₂ layer in Omstead et al.'s method, in order to provide an adhesive region on which copper material may be deposited.

Examiner rejected Claim 2 under 35 U.S.C. 103(a) as being unpatentable over Omstead in view of the following remark.

Regarding claim 2, further comprising depositing multiple layers of Ru and RuO₂ between the inter-level dielectric substrate and the copper layer. (col. 2, lines 20-40).

Examiner rejected Claim 3 under 35 U.S.C. 103(a) as being unpatentable over Omstead in view of the following remark.

Regarding claim 3, further comprising depositing the RuO₂ layer(s) on the Ru layers(s) using an atomic layer deposition technique. (col. 3, lines 55-60).

Examiner rejected Claim 4 under 35 U.S.C. 103(a) as being unpatentable over Omstead in view of the following remark.

Regarding claim 4, further comprising depositing the RuO₂ layer(s) on the Ru layer(s) using a thermal oxidation technique. (col. 6, lines 65-67).

Examiner rejected Claim 5 under 35 U.S.C. 103(a) as being unpatentable over Omstead in view of the following remark.

Regarding claim 5, further comprising depositing the RuO₂ layer(s) on the Ru layer(s) using an electrochemical technique. (col. 6, lines 25-30).

Examiner rejected Claim 6 under 35 U.S.C. 103(a) as being unpatentable over Omstead in view of the following remark.

Regarding claim 6, further comprising depositing the RuO₂ layer(s) on the Ru layer(s) using physical vapor deposition. (col. 6, lines 25-30).

Examiner rejected Claim 7 under 35 U.S.C. 103(a) as being unpatentable over Omstead in view of the following remark.

Regarding claim 7, further comprising depositing the RuO₂ layer on the Ru layer using an atomic layer deposition technique. (col. 6, lines 25-30).

Examiner rejected Claim 8 under 35 U.S.C. 103(a) as being unpatentable over Omstead in view of the following remark.

Regarding claim 8, further comprising depositing the RuO₂ layer on the Ru layer using a thermal oxidation technique. (col. 6, lines 65-67).

Examiner rejected Claim 9 under 35 U.S.C. 103(a) as being unpatentable over Omstead in view of the following remark.

Regarding claim 9, further comprising depositing the RuO₂ layer on the Ru layer using an electrochemical technique. (col. 6, lines 25-30).

Examiner rejected Claim 10 under 35 U.S.C. 103(a) as being unpatentable over Omstead in view of the following remark.

Regarding claim 10, further comprising depositing the RuO₂ layer on the Ru layer using physical vapor deposition. (col. 6, lines 25-30).

Rule 131 Declaration

With reference to the rejection of Claims 1-10 under 35 U.S.C. 103(a), Applicant notes that Omstead was filed August 1, 2002, and is related to provisional application No. 60/354,437, filed February 5, 2002. Presumably, Omstead was published on or about October 5, 2003. Omstead is a patent disclosing, but not claiming, Applicant's invention published or patented less than a year before Applicant's filing date of July 12, 2002.

Applicant herewith files a Rule 131 Declaration wherein one of the Applicants declares that the Applicants conceived the invention prior to February 5, 2002. One of the Applicant submits evidence of the invention being conceived and made in Applicant's laboratory at least as early as April 1, 2001. Further, one of the Applicants received a Texas Advanced Technology Grant related to the invention described in the Application in or about October 2001. Applicant filed a provisional patent application relating to the invention on July 12, 2002; and the current Application was filed June 20, 2003 and claims priority to the above referenced provisional patent application.

One of the Applicants further declares that he exercised diligence in pursuing the invention from at least April 1, 2001 through February 5, 2002, the earliest possible known priority date for Omstead reference, through July 12, 2002, the date of Applicant's provisional patent application.

37 C.F.R. § 131 provides, in pertinent part, as follows:

Affidavit or declaration of prior invention.

(a) When any claim of an application...is rejected, the inventor of the subject matter of the rejected claim...may submit an appropriate oath or declaration to establish invention of the subject matter of the rejected claim prior to the effective date of the reference or activity on which the rejection is based...

Prior invention may not be established under this section if either:

(1) The rejection is based upon a U.S. patent or U.S. patent application publication of a pending or patented application to another or others which claims the same patentable invention as defined in § 1.601(n); or

(2) The rejection is based upon a statutory bar.

(b) The showing of facts shall be such, in character and weight, as to establish reduction to practice prior to the effective date of the reference, or conception of the invention prior to the effective date of the reference coupled with due diligence from prior to said date to a subsequent reduction to practice or to the filing of the application. Original exhibits of drawings or records, or

photocopies thereof, must accompany and form part of the affidavit or declaration of their absence satisfactorily explained.

An antedating affidavit establishing conception and reduction to practice commensurate in scope with a reference disclosure and at a date prior to the effective date of the reference is adequate to overcome the reference as prior art. *In re Stryker*, 435 F.2d 1340, 168 U.S.P.Q. 372 (C.C.P.A. 1971).

An anticipatory disclosure, not a statutory bar, may be removed as a reference against a generic claim by a Rule 131 affidavit showing prior reduction to practice of as much of the claimed invention as the reference shows. When that species of the generic invention that has been completed prior to the effective date of the reference would make obvious to one of ordinary skill in the art the species disclosed in the reference, the reference may be said to have been “indirectly antedated.” All that is required is to establish that facts set out in an affidavit are such as “would persuade one of ordinary skill in the art to a reasonable certainty that the applicant possessed so much of the invention as to encompass the reference disclosure.” *In re Schaub, Bernady, and Weiss*, 537 F.2d 509, 190 U.S.P.Q. 324 (C.C.P.A. 1976).

Based on the enclosed Rule 131 Declaration, Applicant has removed Omstead as a reference with respect to Claims 1–10.

Claims Rejections – 35 USC §102(e)

Examiner rejected Claim 25 under 35 USC 102(e) as being anticipated by Omstead in view of the following remark:

Omstead et al. teaches a method of controlling and containing copper diffusion during the integration of copper interconnects during the fabrication of integrated circuits, comprising:

preparing an inter-level dielectric substrate 304;
depositing one or a plurality of layers of RuO₂ 404 on the inter-level dielectric substrate 304; and
depositing copper 604/704 on the RuO₂ layer. (FIGS. 7-8, col. 25-40).

Examiner rejected Claim 26 under 35 USC 102 (e) as being anticipated by Omstead in view of the following remark:

Regarding claim 26, further comprising depositing the RuO₂ layer on the inter-level dielectric 304 using an atomic layer technique (col. 3, lines 55-60).

Examiner rejected Claim 27 under 35 USC 102 (e) as being anticipated by Omstead in view of the following remark:

Regarding claim 27, further comprising depositing the RuO₂ layer on the inter-level dielectric using an electrochemical technique. (col. 3, lines 55-60).

Examiner rejected Claim 28 under 35 USC 102 (e) as being anticipated by Omstead in view of the following remark:

Regarding claim 28 further comprising depositing the RuO₂ layer on the inter-level dielectric using a thermal oxidation technique. (col. 3, lines 65-67).

Examiner rejected Claim 29 under 35 USC 102 (e) as being anticipated by Omstead in view of the following remark:

Regarding claim 29, further comprising depositing the RuO₂ layer on the inter-level dielectric using a physical vapor technique. (col. 6, lines 25-30).

Examiner rejected Claim 31 under 35 USC 102 (e) as being anticipated by Omstead in view of the following remark:

Omstead et al. teaches a method of controlling copper diffusion during the integration of copper interconnects during integrated circuit fabrication, comprising using Ru 408 as a diffusion barrier (Fig. 8, col. 5, lines 30-35).

Examiner rejected Claim 32 under 35 USC 102 (e) as being anticipated by Omstead in view of the following remark:

Regarding claim 32, further comprising eliminating a copper seed layer (Fig. 8, col. 5, lines 30-35).

Examiner rejected Claim 33 under 35 USC 102 (e) as being anticipated by Omstead in view of the following remark:

Omstead et al. discloses a method of controlling copper diffusion during the integration of copper interconnects during integrated circuit fabrication, comprising using Ru 504 and RuO₂ 404 as a diffusion barrier 9 (figs. 7-8).

Examiner rejected Claim 34 under 35 USC 102 (e) as being anticipated by Omstead in view of the following remark:

Regarding claim 34, further comprising eliminating a copper seed layer. (Fig. 8, col. 5, lines 30-35).

Rule 131 Declaration

With reference to the rejection of Claims 25-29, and 31-34 under 35 U.S.C. 102(e), Applicant notes that Omstead was filed August 1, 2002, and is related to provisional application No. 60/354,437, filed February 5, 2002. Presumably, Omstead was published on or about October 5, 2003. Omstead is a patent disclosing, but not claiming, Applicant's invention published or patented less than a year before Applicant's filing date of July 12, 2002. Applicant references herein a Rule 131 Declaration wherein the Applicant avers as set forth above.

Claim 1 of Omstead provides as follows:

1. A method of forming conductive copper lines in a semiconductor device, the method comprising:
 - (a) providing a dielectric structure having a surface with recessed features formed therein;
 - (b) depositing a ruthenium oxide layer over the surface of the dielectric structure;
 - (c) forming a bilayer of ruthenium oxide and metallic ruthenium from the ruthenium oxide layer, comprising depositing a layer of metallic ruthenium on the ruthenium oxide layer; and
 - (d) forming copper conductive lines in the recessed features.

An antedating affidavit establishing conception and reduction to practice commensurate in scope with a reference disclosure and at a date prior to the effective date of the reference is adequate to overcome the reference as prior art. *In re Stryker*, 435 F.2d 1340, 168 U.S.P.Q. 372 (C.C.P.A. 1971).

An anticipatory disclosure, not a statutory bar, may be removed as a reference against a generic claim by a Rule 131 affidavit showing prior reduction to practice of as much of the claimed invention as the reference shows. When that species of the generic invention that has been completed prior to the effective date of the reference would make obvious to one of ordinary skill in the art the species disclosed in the reference, the reference may be said to have been “indirectly antedated.” All that is required is to establish that facts set out in an affidavit are such as “would persuade one of ordinary skill in the art to a reasonable certainty that the applicant possessed so much of the invention as to encompass the reference disclosure.” *In re Schaub, Bernady, and Weiss*, 537 F.2d 509, 190 U.S.P.Q. 324 (C.C.P.A. 1976).

Based on the enclosed Rule 131 Declaration, Applicant has removed Omstead as a reference with respect to Claims 25-29 and 31-34.

Conclusion

Applicant respectfully submits that Claims 1-10, 25-29, and 31-34, now pending, are in condition for allowance. A Notice of Allowance is therefore requested.

If the Examiner has any other matters which pertain to this Application, the Examiner is encouraged to contact the undersigned to resolve these matters by Examiner’s Amendment where possible.

Favorable consideration of the pending claims is respectfully requested.

Respectfully Submitted,

A handwritten signature in dark ink, appearing to read "Mike L", is written over a horizontal line.

Michael Cameron
Registration No. 50,298

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Jackson Walker L.L.P.
2435 North Central Expressway, Suite 600
Richardson, TX 75080
Tel: (972) 744-2902
Fax: (972) 744-2909